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APPLE-ORCHARD RENOVATION

ORCHARD RENOVATION involves tillage or some substitute therefor, fertilizing, pruning, insect and disease control, and such other operations as special conditions may require—the same operations, in name, that make up good orchard maintenance. The objects to be attained and the manner in which the details are carried out make up the difference between renovation and maintenance, as these terms are generally used.

An apple orchard in need of renovation implies an orchard suffering from neglect, and neglect is personal. The personal side of fruit growing—the "personal equation" or the man "behind the tree"—is always an important factor in successful fruit culture. Perhaps it is the most important factor.

Orchards that are unproductive and unprofitable because of neglect are far too common. They are to be seen in most regions where apples are grown. In sections where they are produced commercially such orchards are likely to be a serious menace, because they usually harbor injurious insects and diseases. Thus they become centers from which pests and parasites spread to well-cared-for orchards, thereby making it more difficult and expensive than it would otherwise be to keep such orchards free from insect and disease troubles.

In some States a neglected orchard is practically declared by law to be a public nuisance and is treated accordingly. If the owner will not clean it up, public officials do it, and the expense becomes a lien on the property until paid.

Where an orchard is well located but has become unprofitable through lack of care, it will usually pay to renovate it. There are many examples that substantiate the general principle. In some sections growers have made the practice of securing long-time leases on orchards that have good potential possibilities but which are not paying because of neglect or improper care, and then through renovation processes and improved management they have turned them into profitable enterprises.

As a rule, a much-neglected orchard does not justify its existence. If an orchard is worth keeping it is worth giving good attention; otherwise, the trees merely encumber the ground and interfere with its use for other purposes. If an apple tree is not of value for fruit production it may be worth converting into tool handles, plane blocks, and other useful things.

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APPLE-ORCHARD RENOVATION.

H. P. GOULD, *Pomologist, Office of Horticultural Investigations, Bureau of Plant Industry.*

CONTENTS.

THE PROBLEM STATED.

AN APPLE TREE of bearing age is successful, other things being equal, in proportion to the abundance and regularity of the crops of high-grade fruit which it produces. So measured, many orchards throughout the country are unsuccessful—in fact, have been so neglected or mismanaged as to become of little importance from any standpoint. Such orchards are found in sections where only the home orchard or fruit garden has been planted, in regions where orchards of considerable size are more or less isolated, and, too frequently, in the recognized commercial apple-producing districts.

While the reasons for neglect are not a part of the present problem, it may be noted that many times trees are planted without the grower having adequate knowledge of the requirements of apple culture. A general farmer often adds a commercial apple orchard to his farm only to find that it conflicts with some of his other activities. The orchard requires spraying, perhaps, when the corn needs cultivating, or the tillage of the orchard needs to be done when the haying or grain harvest should receive attention. In such conflicts the orchard is likely to be given second place. The trees will still be there after the grain is in the shock and the corn "laid by."

Not every neglected orchard is worth the time and energy necessary to renovate it. Many factors of fundamental importance require consideration: (1) The orchard must be on a good site. If the soil is underlain near the surface by hardpan or by a ledge of rock, if it is in a low place where it is poorly drained, or if it occupies a site having a relatively low elevation where freezing temperatures and late spring frosts are likely to cause damage during the blossoming period, it would probably be better to abandon the site. (2) It is important that the trees have good vitality. Trees that have decayed trunks, those badly diseased by cankers which girdle the larger limbs and greatly deplete their vitality, or those which for

any other reason are much weakened would not possess vitality enough to make a good growth even under the best of cultural conditions. (3) Another factor is the variety. If for any reason the varieties represented in the orchard are undesirable there would be no object in making the trees more productive unless in connection with the renovation it is practicable to top-graft the trees to desirable sorts. Under some conditions this operation may offer considerable promise.

One naturally thinks of an orchard which is in need of renovation as an old orchard. However, there is no invariable connection between age and the condition of the trees. If a tree is badly neglected from the time of planting it stands small chance of ever reaching any considerable age, while a tree that is neglected for a few seasons and then comes under intelligent care may be comparatively easy to bring into a productive condition.

FIG. 1.—An apple orchard of the Yellow Newtown (*Albemarle Pippin*) variety; a proper subject for renovation.

TYPES OF ORCHARDS THAT MAY BE RENOVATED.

Since no two orchards are alike with respect to their condition of neglect and the state of depletion into which they have fallen, the details of renovation must be governed by conditions. Some examples of orchards which are subjects for treatment may well be studied here.

Figure 1 shows some trees of the Yellow Newtown (*Albemarle Pippin*) variety which have had very little attention for a long time and have been utterly neglected with regard to pruning. They are growing on fairly rich soil. When they were young they probably received no particular attention with respect to being shaped, and as a result the tops are composed of a mass of irregu-

larly placed branches that crisscross in such a way as to make it difficult to work them over into satisfactory form; but if the trees possess good vigor and are free from depleting diseases that can not be readily controlled, the weakened, dying wood and also a good deal of the smaller growth can be pruned out, leaving the stronger, better branches to aid in developing the top in the future.

Figure 2 shows another type of neglected tree. These trees are on poor land which is subject to drought. Their general appearance suggests starvation, as well as neglect with respect to pruning and in other ways.

The tree shown in Figure 3 looks thrifty and vigorous and appears to possess a large bearing surface, with the top well opened to sunlight. It may not require immediate consideration from the standpoint of renovation, yet a tree pruned as this one has been

FIG. 2.—An apple orchard in which the trees need stimulating rather than heavy pruning as a means of rejuvenation, though rather heavy heading back is suggested.

presents serious problems to the grower who looks ahead a few years. The particular difficulty in this case has been with the pruning. Apparently this tree was well formed in the beginning, but the trees in the orchard where it stands were planted too close together, and there has been a strong tendency for the branches to go straight up toward the light as the trees increased in size. The limbs, when crowded as they grew upward, were not headed back, and as a result they have continued to extend into the air, making it difficult to gather the fruit. Where the branches are as long and slender as in this tree the fruit is likely to suffer seriously through being swayed about by the wind. Furthermore, in pruning this tree the small interior branches which put forth on the long limbs have practically all been cut off, thus removing every possibility, under the present plan of management, of fruit being borne well within the

center of the tree and throughout the top. The system of pruning that has been followed has thrown the bearing surface to the top of the tree and to the exterior. This is commendable, in that it has

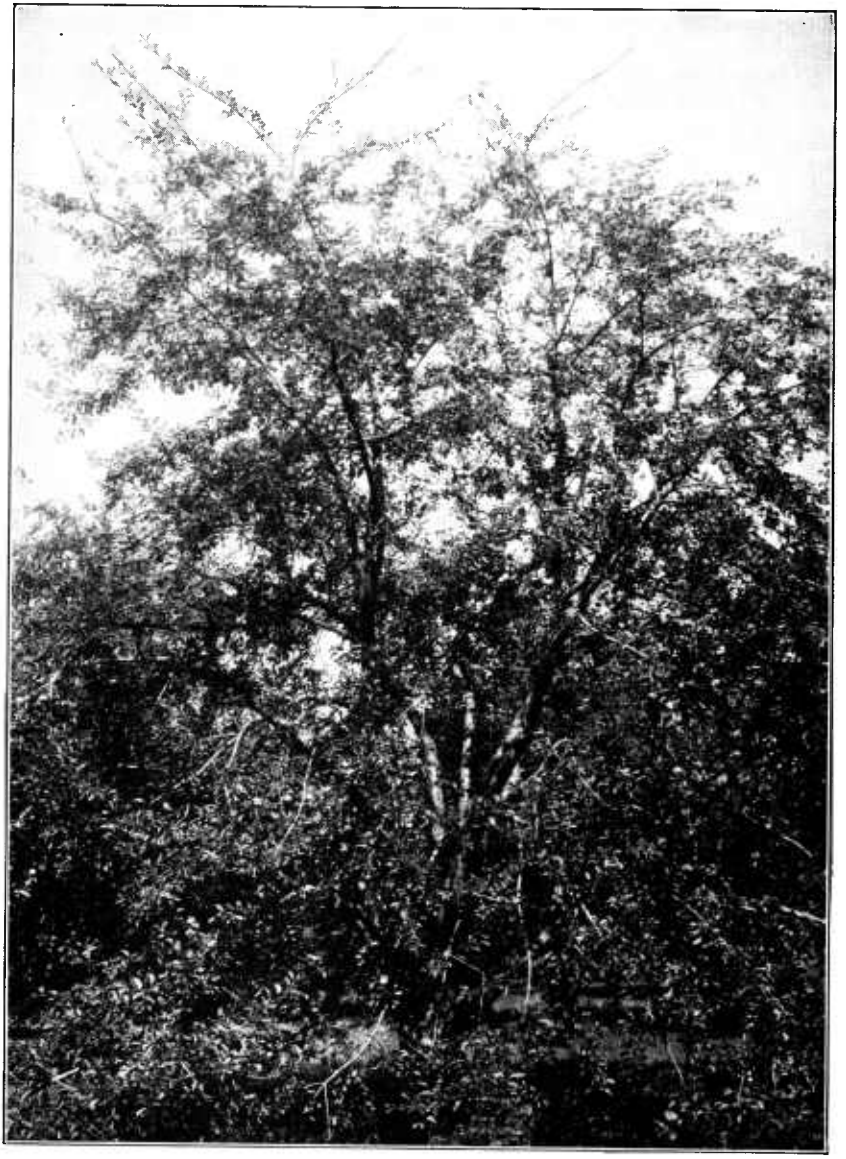

FIG. 3.—An apple tree which has been deliberately given its present form and is an "ideal" of its owner. Note that too much of its bearing surface is excessively high; and the small growth in the interior, which if allowed to remain would in time develop fruit spurs, has nearly all been pruned off.

kept the top of the tree well open to the sunlight, but it could have been accomplished while branches which would eventually have developed fruit spurs were yet retained within the center of the tree.

At some future time the owner of this tree will undoubtedly be face to face with the problem of lowering the bearing surface.

SOME IDEALS AS A GUIDE.

In the renovation of old apple trees the starting points will vary so widely that it will not be possible to work toward any particular form of top. It is well, however, for the one who goes about such an undertaking to have certain ideals in mind. Such ideals will come readily to the mind of the experienced grower, but the one who is

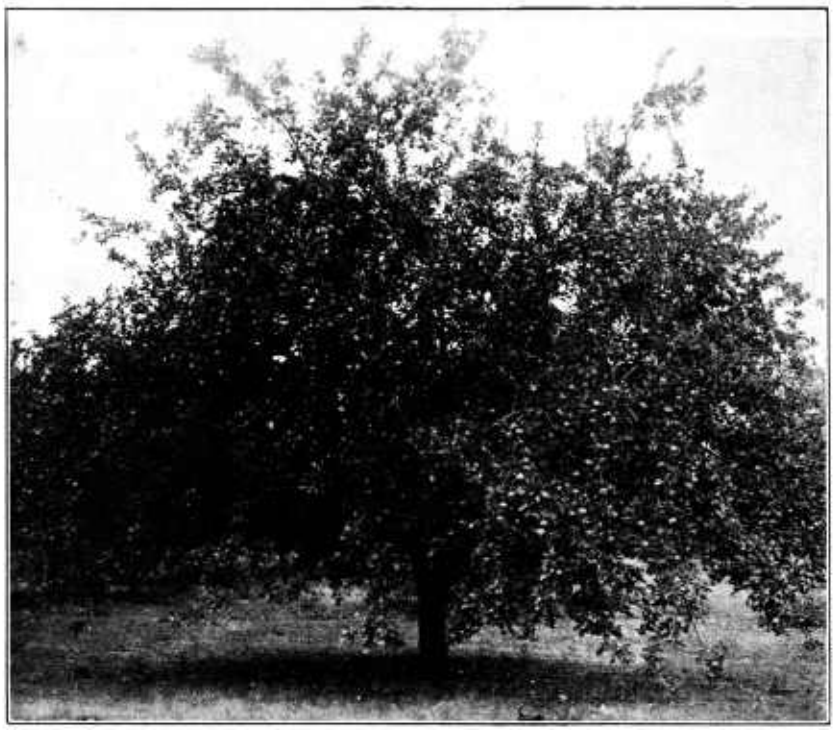

FIG. 4.—An excellently formed apple tree of the Smith Cider variety, 30 years old; a type of tree that may be considered fairly ideal.

without experience will find it helpful to consider some well-formed trees.

A Smith Cider apple tree about 30 years old is shown in Figure 4 as it appeared the latter part of July. Though perhaps not an ideal tree in every respect, it may be noticed that the top, while possessing great bearing surface, is not so dense but that light may be seen through the foliage coming from the opposite side of the tree. This must mean a fairly open top, for the tree is a rather large one. The bearing surface is distributed throughout the top. Furthermore, it is comparatively low headed, and the fruit can be harvested without much climbing.

Some Maiden Blush apple trees 30 years old are shown in Figure 5. While these trees are rather large and tall, what has been said about the tree in Figure 4 applies equally well in this case.

Figure 6 shows how fruit spurs may be successfully conserved and thoroughly distributed over a wide bearing surface of the top of a large tree.

The operations which enter into orchard renovation are the same as those which enter into good orchard maintenance and management. In apple-orchard renovation the grower must consider soil management and fertility, pruning, and spraying from the standpoint of reconstruction rather than that of maintenance.

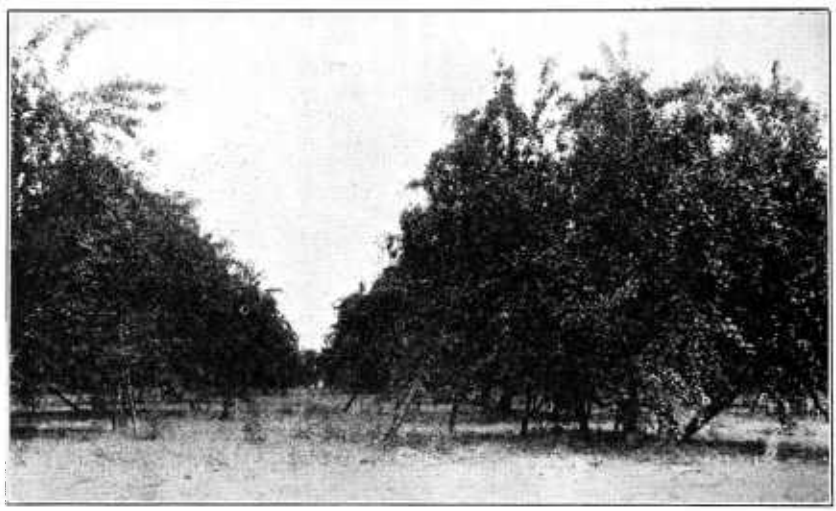

FIG. 5.—Maiden Blush apple trees, 30 years old, which have many desirable characteristics as to form, distribution of bearing surface, and in other respects.

SOIL MANAGEMENT AND FERTILITY IN APPLE-ORCHARD RENOVATION.

No two orchards requiring renovation will be on soils which are in the same state of fertility or in the same physical condition. In most instances, however, the soil probably will have been left uncultivated for a considerable time. If it is naturally strong and productive it may be covered with a tough sod, which usually develops a heavy growth of grass; it may be covered with sassafras, locusts, and other brushy growth, depending upon its location; or it may be in a run-out condition and produce only a small scattered vegetation, consisting mostly of weeds. The condition of the soil is naturally an important factor. If it is of the first type suggested, the trees probably are fairly strong and vigorous and have been making a large annual growth. If it is a poor run-out soil, the tree growth will be correspondingly small and weak. It will at once be apparent that the soil problems in these two cases are very different.

Since clean cultivation supplemented by some type of cover crop is a standard method of soil mangement in orchards—and it is usually the one by which other systems are judged—the first thing to be de-

cided is whether the orchard shall be plowed. If the land is covered with locusts, sassafras, or other brush, the necessity of clearing such growth away and subduing future growth is obvious. If the trees are standing in soil that is extremely rocky or on a hillside or slope where there is danger of the soil washing if plowed, the breaking of the sod may be unwise; or, some other condition may render sod culture advisable; but unless there is good reason for doing otherwise the land should be plowed early in the spring, or during the winter if in a section where winter plowing is practicable. Plowing is sometimes done late in the fall after the trees have become thoroughly dormant.

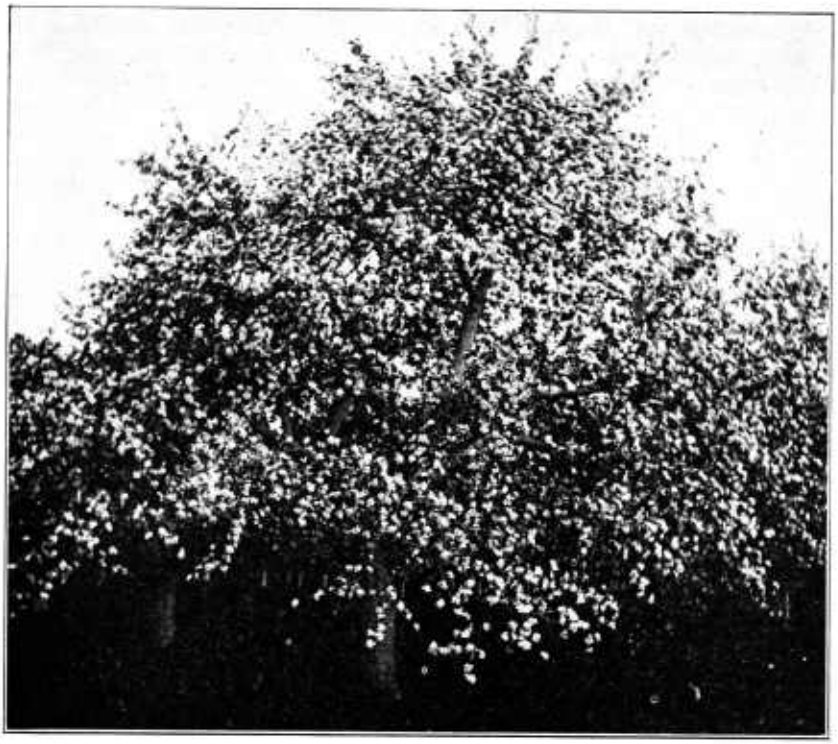

FIG. 6.—An apple tree of mature age which has a good distribution of its fruit spurs.

As early in the spring as the soil can be worked the plowing should be followed by harrowing or disking in order to pulverize it and work the surface down from the more or less rough condition left by the plow. If worked into a fine granular condition, the surface will absorb the rain more readily and there is less tendency to wash than if a very fine dust mulch is secured. Heretofore emphasis has been placed on the dust mulch as a means of conserving soil moisture. The emphasis might better be placed on the control of weed growth by tillage and putting the surface in the best possible condition to absorb moisture. The difficulty with which a very fine powder or dust of any kind absorbs moisture is a matter of common observa-

tion. Tillage of the soil also serves to aerate it and to induce conditions more favorable for the setting free of plant food. Other advantages usually attributed to soil tillage, as compared with sod culture, may be expected to follow. The same objects are to be attained in orchard tillage as in the tillage of other crops. The only question is whether under any given soil condition apple trees, because of the deep penetration of the roots and their wide expanse through the soil, may not be able to secure the plant food and moisture necessary for the desired ends without the results brought about by tillage. However, one of the things of importance generally in the case of apple trees that need renovation is to stimulate more tree growth.

Where the soil has not been plowed for a considerable time the apple-tree roots as a rule will be found near the surface, and if the plow runs too deep many of them will be severed. In this way a large proportion of the root system might be destroyed and the trees more or less severely injured. One must be guided by what one sees. If the plow running to a certain depth is observed to break many roots it should be set to run shallower, but if it is possible to plow at least 7 or 8 inches deep it should be done. It may be practicable to plow deeper in the middle of the space between the tree rows than near the trees.

Where the surface of the ground is not covered too densely with vegetation and where the tree roots are near the surface it may be possible to acomplisn the desired cultivation by using a disk or cutaway harrow early in the spring, when the ground is soft. As a rule, however, this course is not recommended where deeper turning of the soil with the plow is practicable.

As a general thing the breaking of the soil should be followed throughout the growing season by frequent cultivation. The exact number of cultivations will depend upon the soil and other conditions, as in the handling of the soil for any other crop. If the soil contains considerable clay and is easily packed by heavy rains which occur frequently, tillage should be more frequent than under conditions where packing does not occur. In other words, the tillage should be often enough to keep the surface soil loose and in a fine granular condition. This general method of soil management should usually be continued until midseason, the middle of July or the first of August, when ordinarily it would be discontinued for the season. Perhaps a cover crop or a green-manure crop should be put in at this time.

GREEN-MANURE AND COVER CROPS.

A soil which is deficient in humus or decaying vegetable matter is unproductive. Humus is likely to be deficient in the soil of neglected apple orchards, and constant clean tillage tends still further to deplete it. Where an orchard is cultivated frequently during the first part of the season, as noted above, it is a common practice to seed it to a crop which later is plowed in. The vegetation as it decays becomes incorporated in the soil and adds to the supply of humus. Many different crops are used for this purpose. Rye is perhaps the most common of the nonlegumes, while of the legumes, vetch, crimson clover, cowpeas, soybeans, melilotus, and various others are

much used in different sections. A combination of rye and vetch is being more and more widely used.

Local practices must necessarily vary with regard to the time of seeding, plowing under, and other details. Obviously, seeding follows the completion of the season's tillage program except in the case of certain crops, such as cowpeas, which may be seeded in drills 3 feet apart and tillage continued for a time with a 1-horse or with a 2-row cultivator.

In sections where fall plowing is desirable a crop killed by early fall frost may be turned under after the trees become thoroughly dormant; or, in case of rye or vetch, which live over winter, an early spring growth is usually permitted to develop before plowing, for the purpose of gaining as much vegetable matter as possible to add to the soil.

SOD CULTURE OR SOD MULCH.

As an alternative to clean tillage or tillage and green-manure crops, the sod-culture method has its place under some conditions. These conditions are (1) where it is unsafe to break the sod because of the danger of washing; (2) where the soil is so excessively rocky as to make tillage impracticable (such soil conditions sometimes give excellent results with apples); and (3) where, on account of an abundant growth of grass which can be mowed once or twice each season and used for a mulch, moisture and other conditions can be satisfactorily maintained without recourse to tillage.

Straw or other vegetation is sometimes available for use as a mulch in an orchard instead of grass, which may grow there only sparingly. Such a mulch may conserve soil moisture, besides adding humus to the soil. Not infrequently, however, where the sod-culture method is employed it must be accompanied by a wise system of soil fertilization to be fully successful. This is also true of other systems of soil management.

So far as humus is concerned, green-manure crops may be made to take the place of stable or barnyard manure. With an abundance of manure to apply, a grower could dispense with green-manure crops, though cover crops for other reasons than the humus supply might be desirable.

FERTILIZERS AND MANURES FOR APPLE TREES.

Apple trees need the same kind of plant foods that other plants require, and there is perhaps less difference in the proportions of the different food elements required, compared with other plants, than is sometimes supposed. A fairly high degree of soil fertility is desirable in orchard renovation because of the need, in general, of stimulating growth.

In beginning the renovation of an orchard it is usually a safe practice to make a liberal application of stable manure whenever available. This is true whether the orchard is to be plowed and cultivated or maintained under sod culture. The addition of humus by this means is frequently of even greater importance than the plant food which is supplied thereby.

A soil may contain plant food in abundance, but it may be so locked up in chemical combinations that it is not available for the

use of plants. The conditions brought about by the addition of humus to the soil tend to set plant food free. If the orchard is to be maintained in sod, manure, if applied, will gradually break down and work into the soil, and it will tend to increase the growth of the grass, thus supplying a larger quantity of mulch than would otherwise be available in the orchard.

In connection with the use of commercial fertilizers, many questions arise. The plant foods supplied in fertilizers comprise mainly nitrogen, phosphorus (commonly referred to as acid phosphate), and potash.

If quick results are desired, nitrogen is applied in the form of nitrate of soda or sulphate of ammonia, while dried blood, tankage, and fish scrap will supply it more gradually. The acid phosphate in commercial fertilizers is usually in the form of finely pulverized phosphatic rock that has been treated with an acid or in bone meal which has been treated to make the phosphorus in it available for the use of plants. Potash is commonly used in the form of muriate of potash.

The real problem is to determine the element or elements of plant food which are limiting crop production. If the orchard which is being renovated consists of only a few trees, the use of a complete fertilizer will undoubtedly be fully justified, since at most only a small quantity of fertilizer is involved; but if the orchard is a commercial enterprise the businesslike proceeding will be for the grower to select a representative portion of it and to apply nitrogen in one of the quick-acting forms to one group of trees, potash to another group, and phosphoric acid to another. To still other groups he should apply these three plant foods in various combinations, using on different groups nitrogen and potash, nitrogen and phosphoric acid, phosphoric acid and potash with nitrogen omitted, and possibly a complete fertilizer. Trees receiving no fertilizer of any kind should be selected at the same time to be observed in comparison with those receiving fertilizers.

This, of course, would mean the use of a considerable number of trees. Not less than three should be used in each group, and preferably a larger number. To guard against the overlapping of the results of the different foods, trees not treated at all should surround each group to which plant food is applied. The same fertilizer treatment should be given to each group of trees for at least two or three years. Perhaps even a longer period would be advisable before final conclusions were reached, but by the second or third season some indication of results would probably appear. In case nitrogen was very much needed results might be expected the first season in the case of trees receiving nitrogen in a quick-acting form.

Careful observations must be made to determine what these different plant-food treatments accomplish. The trees should be studied from time to time to note their general appearance; and the fruit, when harvested from the different groups of trees, should be measured and carefully compared. This will mean extra work, but any course of procedure that is worth while requires some attention to details. As the grower studies the results of using different plant foods he may find that the trees in one particular group are superior to all the others. He may note that the trees which have received

nitrogen are superior in growth or production to those receiving either phosphoric acid or potash; perhaps, regardless of the combinations with other plant foods, the trees receiving nitrogen are doing uniformly better than those to which any combination omitting nitrogen is applied. This suggests that lack of nitrogen is the limiting factor. But if the available supply in the soil of either phosphoric acid or potash happens to be insufficient for the needs of the trees, the fact may be expected to appear in the response of the trees receiving those plant foods.

Much study of the use of fertilizers in apple orchards has been carried on in recent years by many different investigators. The results have shown that nitrogen is more often lacking in orchard soils than any other one element of plant food. In some cases the apparent value of phosphoric acid is indirect and manifests itself in a more luxuriant growth of grass (of importance as a mulch in case of sod culture), or cover crops in the case of tilled orchards. Potash has not proved to be a limiting factor in fruit production to the extent commonly supposed.

Manure and other forms of plant food are generally applied broadcast in the spring. Under some conditions manure can be applied during the winter. It has been found through experiment, however, that nitrogen, if deficient and applied just about the time the buds are beginning to swell in the spring, will usually produce an almost immediate effect and may influence the setting of the fruit the current season; but if applied later, as for example after the blossoming period, nitrogen will not as a rule greatly affect the current season's crop, although it may show comparatively early in the season in the darker color of the foliage, in a more vigorous growth of wood, and in the formation of fruit buds for the next season's crop.

No arbitrary directions can be given as to the most economical quantities of the various plant foods to apply since the needs will vary with different soil and tree conditions. Trial rates suggested for mature trees are: Nitrate of soda, 4 to 6 pounds per tree; muriate of potash, 2 to 3 pounds; and acid phosphate, about 5 pounds. These quantities, of course, are subject to local variation and to the results of experience gained as the work progresses, or as suggested by knowledge of the general plant-food requirements of any particular soil.

PRUNING THE TREES.

The place which pruning occupies in the renovation of apple trees has been indicated indirectly in the discussion of Figures 1 to 6. The objects to be gained by pruning trees of bearing age are: To remove the dead limbs, many of which are likely to be found on neglected trees; to remove superfluous wood, especially with a view to opening the tops of the trees to the sunlight; to bring the trees into manageable shape; and to promote the development of fruit spurs and other fruit-bearing wood at points where fruit can be borne most advantageously. Most of the pruning should be done while the trees are dormant. In some of the milder sections it will be convenient to do this during the winter, while in the more severe sections early spring will usually be preferable.

Strong, thrifty fruit buds are not likely to develop in densely shaded parts of a tree. Fruit spurs that are continuously and densely

shaded for a long time may be expected to weaken and eventually die. The tendency for every growing branch and twig is to reach out toward the sunlight. It is for this reason that trees planted too close together send out long slender limbs that are bare of secondary branches. The condition in the top of an individual fruit tree which is allowed to become too dense through the development of too many branches is not unlike that which exists in an orchard where the trees are planted too close. The competition is too intense. Every branch in a tree top is competing for plant food and for sunlight with every other branch. Some branches that are less favorably situated in the trees than others die because the struggle for existence becomes too great; hence the large number of dead limbs that occur in a tree which has been neglected as to pruning. A dead limb is rarely to be found in a properly pruned apple tree. Wherever one occurs it should be removed.

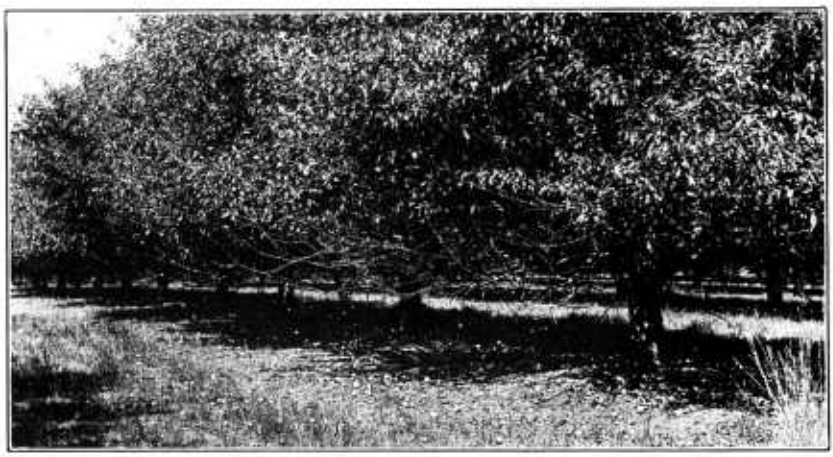

FIG. 7.—Apple trees which are exceedingly difficult to prune because they are so brushy. They have been developed without any plan. Sheep pastured in the orchard have eaten the leaves from the lower branches.

The removal of limbs for the purpose of thinning the top requires considerable judgment. The trees shown in Figure 7 are suggestive in this connection. Pruning to thin the top is done while the trees are dormant and therefore when there are no leaves on them. Until one has had considerable experience he may think, with the branches bare of foliage, that he has removed a great deal of wood from the top of the tree, and then later, when the foliage is fully developed, the top may look as dense and impenetrable as before it was pruned. The inexperienced pruner is more likely to remove too few rather than too many limbs. It is important, however, not to go to the other extreme and open the top too much, because if this is done it will expose some of the important limbs to the direct rays of the sun even when the trees are in full foliage; and, with the hot summer sun striking with full intensity on the bare limbs previously shaded, sun scald is likely to occur. This will result in the killing of the bark on the exposed side of the limb, and later it will peel off. Borers and other insects are likely to enter the

wound thus made. The limb so injured will be seriously weakened and perhaps eventually die.

The heading back of trees which have become too high (figs. 3 and 8) is another important step in pruning neglected apple trees as well as those that have been improperly shaped. The effect of heading back a tree like the one in Figure 8 is shown in Figure 9, which, though not the same tree as Figure 8, occurs in the same

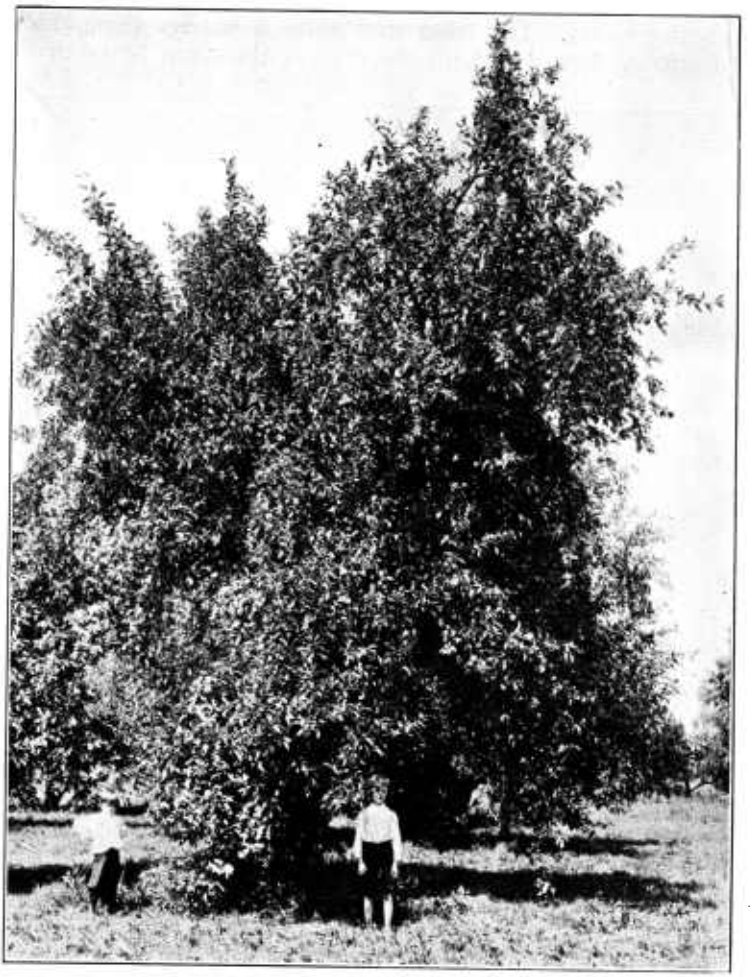

FIG. 8.—A Ben Davis apple tree about 20 years old in northeastern Kansas which has developed a high top. Contrast with Figure 9.

orchard and is comparable. In both cases the trees are of the Ben Davis variety and about 20 years old. The topmost branches of the tree in Figure 9 were cut back from 6 to 10 feet. Before heading back it was about like Figure 8. The new top that is forming will require some thinning out at the annual pruning, which will occur during the next dormant period, but with proper attention it will be possible to keep the top well opened for the

development of a large bearing surface distributed throughout the tree top and yet keep it reasonably low, so that spraying, harvesting, and other operations can be carried on with ease and efficiency.

The trees shown in Figures 1 and 2 represent quite different problems in pruning. The former requires thinning out and some heading back. Many sprouts (water sprouts) have developed. Some of these should come out, as well as some of the older limbs, but some of the younger growth may be retained, to be developed into new fruit-bearing wood. The trees in Figure 2 require little thinning out, but cutting 6 or 8 feet off the tops of the main limbs probably

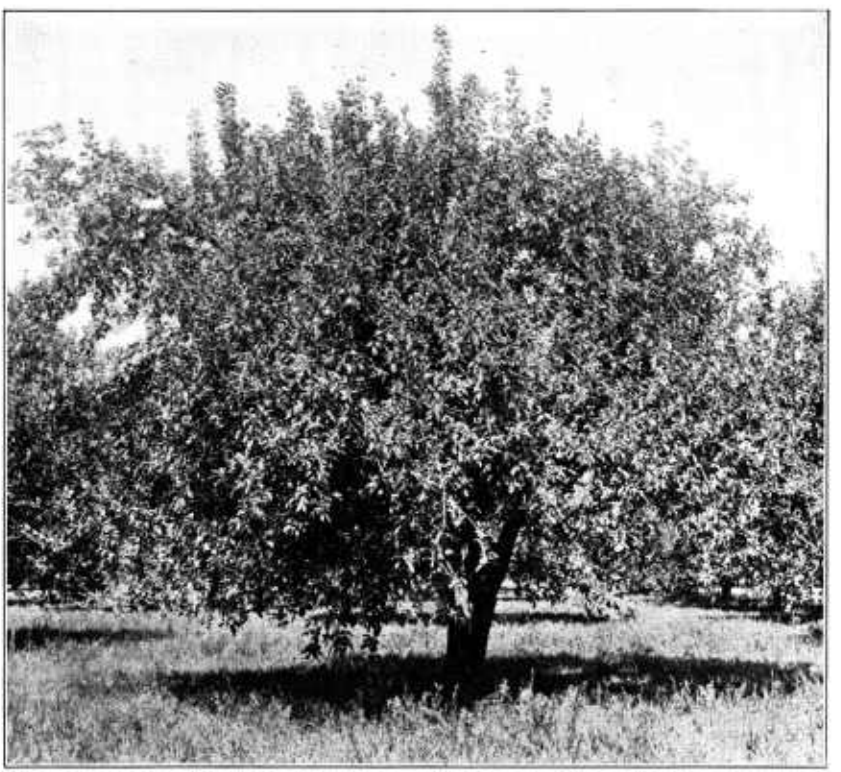

FIG. 9.—A Ben Davis apple tree which has been headed back 6 to 10 feet. This tree is in the same orchard with the tree shown in Figure 8 and comparable with it. The illustration shows the tree in midsummer following pruning during the preceding dormant period.

would be beneficial. This, followed by tillage and abundant fertilizing, would be expected to develop new wood and increase the vigor of the trees. In cutting back main limbs, as here suggested, it is highly important to cut just above a side limb, thereby avoiding a stub which otherwise would result.

In Figure 10 still another type of tree is shown. These trees are about 45 years old and are on fairly strong soil. They have been poorly pruned and neglected generally. Very heavy heading back was practiced, as may be seen by the tree in the foreground. Before cutting back, the apples in the tops of the trees could not be reached

from a 36-foot extension ladder. In order not to check the trees too severely the cutting back was extended over two seasons. The trees are shown in August of the first season after the work was begun. The following year the remaining part of the top was cut back. These trees responded remarkably well, only a single tree, and that one nearly dead to begin with, dying as a result of the treatment. The new tops that developed were thinned out and headed back somewhat, and within five seasons some of the trees were producing in a single crop from 20 to as high as 40 bushels of fruit.

FIG. 10.—Apple trees in central Kansas about 45 years old in the process of rejuvenation, which consists largely of heavy cutting back, followed by good culture.

It should here be noted that the extremely heavy cutting back illustrated in Figure 10 is not to be advised as a rule, but under some conditions, of which the case described is an example, it may be followed by excellent results. Furthermore, the variety and the region may well be taken into account in deciding the extent to which the pruning may be carried. In sections where the various canker diseases are serious, or in case of varieties especially susceptible to them, the making of large wounds by heavy pruning, or by any other treatment, is likely to expose the trees to disastrous infections from these diseases.

In general, the needs as to pruning will usually be met by cutting out all dead limbs, thinning out the branches where the tops are so dense as to heavily shade the interior of the tree and heading back the main limbs rather lightly.

In thinning the tops, a general principle to observe is to remove primary or main limbs which start from points well down within the top, rather than to cut off a large number of small secondary branches. The latter course results in the conditions shown in Figures 3 and 11, where the fruit-producing wood has been removed to an undesirable extent from the center of the trees. This manner of pruning places the bearing surface largely toward the outer ends of long branches, rather than being uniformly distributed throughout a top well opened to sunlight by the use of proper pruning methods. Judicious heading back has its place in forcing the desired growth of fruit-bearing wood that is well distributed through the tree in cases similar to those illustrated.

FIG. 11.—Apple trees from which the lower secondary branches have been cut away, thereby removing the fruit-bearing wood that normally develops within the center of a tree that is properly pruned and the top kept sufficiently open to admit the light. These trees also show the ill effect of being planted too close.

WOUNDS MADE IN PRUNING.

The manner in which the wounds resulting from pruning are made is of great importance. Where a long stub is left, as is shown in Figure 12, *A*, it will never heal over. The stub will die, then decay, and in a few years a condition suggested by Figure 13 will be likely to develop. Although the wound shown in Figure 12, *B*, is healing, too much of a stub was left when the limb was removed. Figure 14 shows a wound properly made in removing a limb, which is healing rapidly.

As a rule, where a limb is removed it is not necessary to cover the wound unless it is very large. Even then, there is some doubt whether anything is gained in the healing of the wound by covering it. However, if it will require several seasons to heal, the coating of the exposed surface with paint or grafting wax to protect it from the weather during the period is advisable. There is perhaps nothing better for this than a fairly thick white-lead paint, the lead being thinned with pure linseed oil. Not infrequently the paint peels

off after a time, so that occasional repainting may be necessary if the cut surface is to remain constantly protected. To prevent the drying out of the cambium which has been exposed, some recommend that a coat of shellac be applied to the cut edge of the bark and the adjoining sapwood as soon as the surface has become dry enough to hold it. Following such treatment a mixture of creosote and coal tar has been used in tree surgery with considerable success.

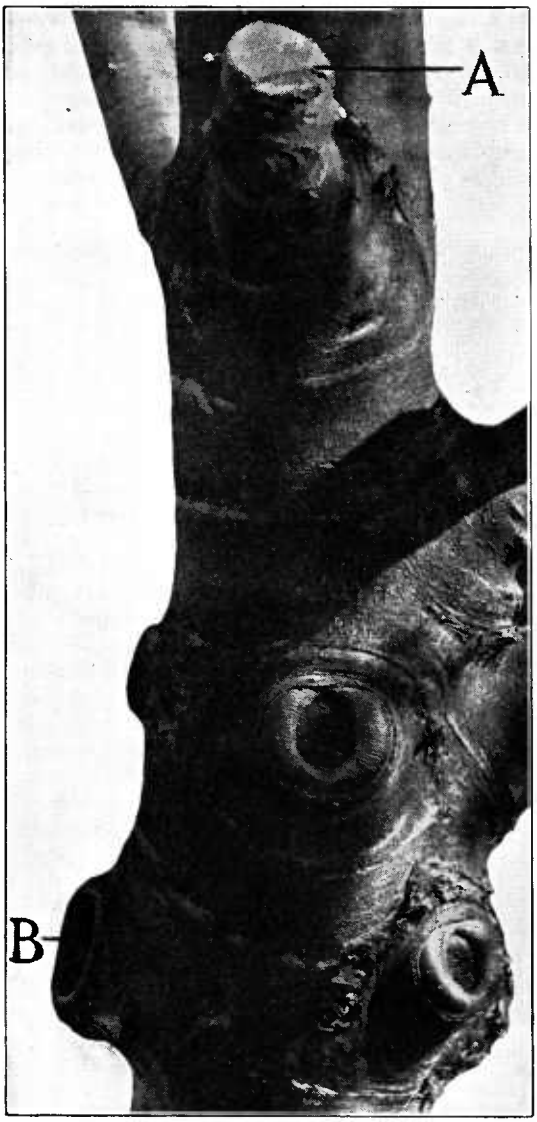

FIG. 12.—Details of pruning. The stub at *A* will never heal over; it will die back and eventually decay. The wound at *B* is healing, but the stub is too long. The other wounds made in the removal of limbs are better done.

PRUNING TOOLS.

While such saws and other implements as the average farm affords can be used in pruning, tools especially designed for the purpose are an advantage. A good type of hand pruning shear is shown in Figure 15. There are various types of pruning saws; the curved one shown in the figure mentioned is a favorite with many growers. The blade in the meat-saw type can be turned so as to adjust it to any angle between limbs. "Lopping shears" have their place in the rougher preliminary work where heavy pruning is required, but long stubs and roughly made wounds are likely to result from their use. For a similar reason an ax is a very poor tool for pruning fruit trees.

SCRAPING THE TRUNKS OF THE TREES.

The trunks and larger limbs of old apple trees often are covered with fragments of dead bark in the process of peeling off. It forms harboring places for insects, is unsightly, and serves no useful purpose unless perhaps very slight protection against drying winds and the cold of winter. These bark fragments may well be cleaned off by scraping lightly with a hoe or other more convenient implement. This is an operation for early spring rather than for the cold winter months, because of the possible protection afforded by the bark.

FIG. 13.—What happens when long stubs are left in cutting off branches.

FIG. 14.—A wound that was properly placed in cutting off a branch. This illustration also shows a union of stub and scion after growing for four seasons.

SPRAYING TO CONTROL INSECTS AND DISEASES.

Spraying is one of the three or four fundamentally important operations in the management of an apple orchard, whether it be a large commercial enterprise or merely a small collection of trees to supply fruit for family use. Insect pests and fungous diseases are controlled largely by spraying, although there are certain diseases as well as insects which have to be controlled by other means.

No extended discussion of spraying can be undertaken here, not only because the field that would have to be covered is so large, but

because the necessary information is provided elsewhere. On request to the Department of Agriculture, there will be sent a list of Farmers' Bulletins that are published by the department and cover a wide range of information on spraying, the control of insects and diseases, and other subjects. In addition, practically all the State agricultural experiment stations and agricultural colleges in those States where apple-orchard interests are of any considerable importance have published bulletins on the control of apple insects and diseases.

The important thing in connection with orchard renovation is to point out the place which spraying occupies in the seasonal program and to direct attention to sources of information. No attempt is here made to work out spraying programs which will protect against the insects and diseases that are likely to occur in the different re-

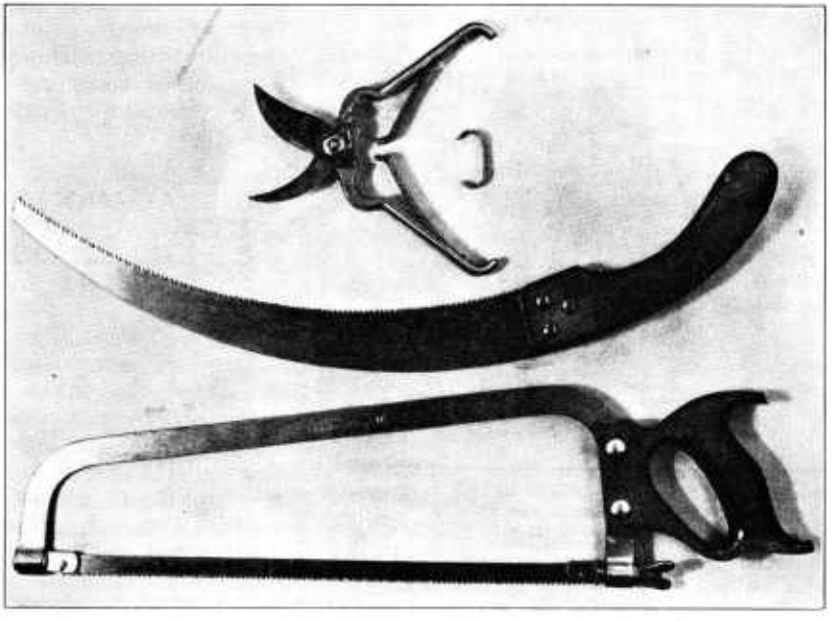

FIG. 15.—Types of pruning tools; a pair of hand pruning shears and two types of pruning saws.

gions of the country. The States have covered this field very thoroughly and the instructions provided in the spray calendars should be followed. It is therefore worth while for each grower to become familiar with the more important insects and diseases that occur in his region, in order to make the most effective applications of fungicides and insecticides. For instance, the apple growers in the North do not need to spray for the control of bitter-rot and apple blotch, though these two diseases are very serious on some varieties in the middle latitudes and in the southern apple districts. On the other hand, the northern grower needs to give more attention to the control of apple scab than do growers in the middle latitudes and the South.

For comparatively small spraying operations a barrel pump such as is shown in Figure 16 will serve the purpose fairly well, especially

if it is equipped with 20 to 25 feet of hose and an extension rod such as is shown in Figure 17. This figure also shows a power sprayer such as is needed for commercial orchard operations.

In some sections considerable attention has been given to dusting apple trees instead of spraying them. In this practice the insecticides and fungicides are diluted with a powder, commonly hydrated lime, rather than with water. Dusting has some advantages over spraying, as it can be done more rapidly and the weight of material that must be conveyed through the orchard is much less than when a liquid spray is used. In its present state of development, however, this method is generally considered to be less effective for the control of most diseases than spraying, although for some chewing insects it has proved quite satisfactory.

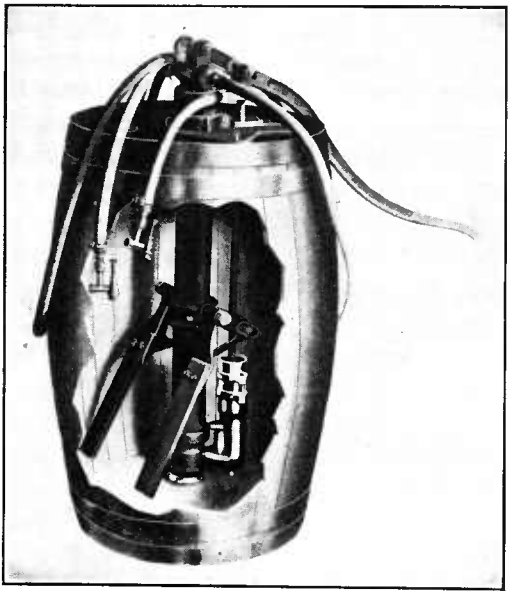

FIG. 16.—A barrel pump suitable for spraying the fruit garden or home orchard.

GENERAL MANAGEMENT OF THE ORCHARD DURING RENOVATION.

Orchard renovation is a process that must be continued over a period of several years before the undertaking is fully accomplished, although under some conditions noticeable results may be obtained even from the first year's work, the improvement being apparent in the crop and in the general condition of the trees. No discouragement should be felt, however, if the results are longer delayed, as they undoubtedly will be when the trees in the beginning are in very bad condition and the soil much depleted.

The general program of cultivation, or of repeated mowing of the grass where sod culture is followed, pruning as the condition of the trees require, spraying, and the use of manure and other plant foods as the appearance and condition of the trees may suggest, should be followed annually. It should be understood, however, that there is very little that is definitely fixed and arbitrary with regard to the general procedure. That grower who most fully grasps the underlying principles and objects to be attained and who takes advantage of varying local and seasonal conditions in carrying forward his work will be the one who will make the most rapid progress and do it most economically.

TOP-GRAFTING AND OTHER SPECIAL PRACTICES.

Reference was made earlier in this bulletin to the possibility of top-grafting trees where they were well located and otherwise desirable except as to variety. Grafting has a very practical field of application. It is not difficult to accomplish, though it is exceedingly exacting with respect to certain details. As a rule, the cleft method of grafting should be used in orchard renovation. The details of cleft grafting are given in Farmers' Bulletin 157, entitled "The Propagation of Plants," and will therefore not be repeated here. It will be helpful, however, to the one who has had no experience to have some suggestions in regard to the application of the method.

The proper time for grafting is in the spring, just before growth starts. Even if the tree which is to be grafted has started slightly into growth it will do no harm; this may even be preferable to doing

FIG. 17.—A power sprayer operated by a gasoline engine, suitable for large commercial orchard operations. The equipment includes extension rods by which the nozzles are elevated to the level of the tree tops.

the grafting too much in advance of the time when growth actually begins. It is, however, of the very greatest importance—in fact, it is essential to success—that the scions be perfectly dormant, the buds of the scions not having swelled, when the grafting is done. This frequently means that the scions must be cut during the winter. If wrapped in newspaper that is slightly moist and placed in sawdust, also slightly moist, in the top of an icehouse in close proximity to but perhaps not actually in contact with the ice, the conditions would probably be almost ideal for holding the scions in good condition. Packed in damp sand and stored in a cellar where the temperature is not above 38° or 40° F. but not below

freezing, scions will also keep in good condition, or they may be buried in the ground in a well-drained place and suitably protected against freezing.

FIG. 18.—An apple tree 14 years old top-grafted to another variety. The grafting was extended over three seasons, and the tree now has grafts that are 4, 3, and 2 years old, respectively. As here shown the tree has numerous limbs, water sprouts, and stubs of the original tree awaiting removal.

Figure 18 shows an apple tree which has been top-grafted by the cleft-graft method. While this grafting was not in connection with the rejuvenation of the tree, it illustrates some important points that need to be considered in every case of top-working. The base of the tree shown in this figure is 14 years old. The oldest grafts

have completed their fourth season's growth. There are other grafts in the tree which have completed three and two seasons' growth each. There are also some ungrafted stubs, limbs, and nu-

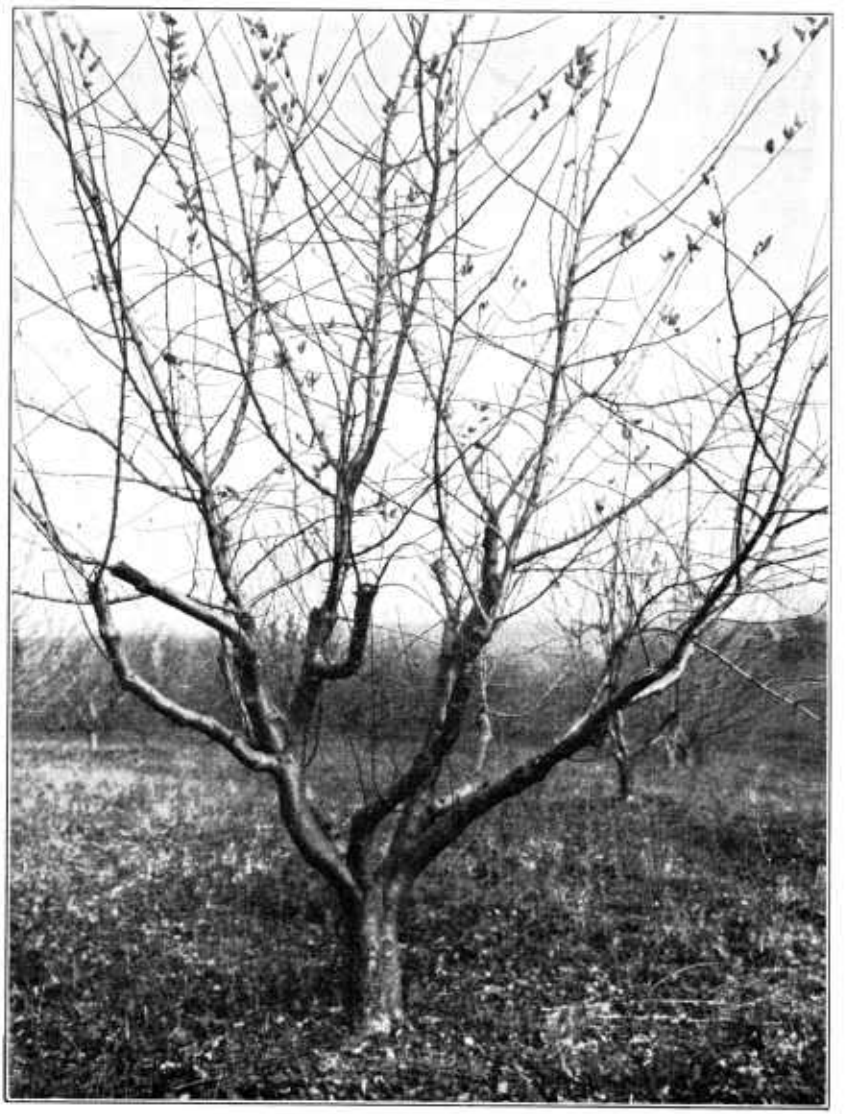

FIG. 19.—A tree similar to the one shown in Figure 18, with the superfluous growth pruned away.

merous water sprouts which should be cut out in the next dormant pruning. The tree is here shown as it appeared in early December.

Figure 19 shows a tree similar to the one in Figure 18 after it had been properly pruned, the ungrafted stubs, water sprouts, and other superfluous growth having been removed. The tree as here shown is in good condition to produce a small crop of fruit the next

season. It is not unusual for grafts to bear some fruit the third season, with a still larger crop the fourth. Bearing will depend somewhat upon the variety. Grafts not more than 3 or 4 years old should not be allowed to bear heavily, even if the fruit sets, because of the danger of the weight of the fruit breaking off the graft at the point of union.

As a rule, a grower takes two or three seasons to work over the entire top of a tree which he is grafting, especially if it is 10 or 12 years old or more. This was the course followed in top-working the trees shown in Figures 18 and 19. The conviction prevails that to cut off at one time all the limbs that are to be grafted causes too much of a check to the tree. It might result in the forcing of an undesirably large number of water sprouts, and possibly the growth of the scions might not be as satisfactory as where the grafting was done more gradually and the growth of the tree was not checked as it would be by cutting off practically all of the limbs. On the other hand, the entire top of a tree, even of considerable size and age, is sometimes grafted at one time with satisfactory results. In the latter case it is usually possible to leave some of the side limbs and branches which do not require grafting, but which will eventually be removed, thus providing the necessary foliage to maintain the tree until the scions grow and function in place of the limbs that were cut off for grafting.

FIG. 20.—An apple tree top-grafted at four years from planting; here shown the last of June following the grafting, which was done the previous April. In this case the limbs were all grafted at one time.

Figure 14 shows the point of union of a scion and stub as it appeared four seasons after the graft was made. The wound just below the graft union, made by removing a branch, is more recent in orgin than the graft, as the limb was allowed to remain to help in nourishing the tree until after the graft should grow, as described

above. The normal healthy healing of a properly made wound is also here shown.

The tree shown in Figure 20 was entirely top-grafted at one time. The illustration shows the tree and grafts the last of June following the grafting, which was done the preceding April. In this instance the inlay method of grafting was used.

FIG. 21.—A young tree top-worked by the method known as tongue or whip grafting.

In Figure 21 a tree is shown which has been planted two or three years and which has been top-grafted by use of the tongue or whip method. The four main limbs desired for the formation of the permanent top have been grafted. This illustration shows the tree after the grafts have made considerable growth and all superfluous limbs have been removed.

In orchard renovation it is frequently desirable to top-work a tree that is much older than those shown in Figures 18 and 19. The problem is then more difficult, at least as to the execution of details,

than in the case of a younger tree. This will be suggested by reference to Figure 22, which shows some large high-topped trees which have been trimmed back for the purpose of grafting. It is difficult and as a rule probably inadvisable to cleft-graft stubs that are much more than 2 inches in diameter, though other methods of grafting may sometimes be used. Trees as large as those shown in Figure 22 can not be cut back very far before reaching points where the wood is old and the bark very stiff and difficult to handle. It is laborious

FIG. 22.—Apple trees which offer serious problems in top grafting because of their large size. It is doubtful whether top-grafting is often practicable in such instances.

to graft large trees, because the work must be done from a ladder or from some other position where it is equally difficult to handle tools; and, what is even more objectionable, the new portion of the top to develop from the grafts will be far above the ground, and the tree will possess all the objections mentioned in discussing trees with exceedingly high tops.

NATURAL BRACES.

Another possible treatment of trees undergoing rejuvenation that may prove helpful in some instances is suggested in Figure 23, showing a method of forming a natural brace. The need of such a brace is likely to exist where trees were not properly shaped when young and at the time the heads were first formed. However, crotches like

the one shown in Figure 23 are not uncommon even in trees that have received fairly good attention. Where they occur there is always the danger of the limbs splitting down. A natural brace is generally easy to develop if the necessary small branches exist, and it forms a secure and permanent support. Such a brace is formed by twisting together or intertwining two small branches and at certain points where they come into contact with each other cutting the opposing surfaces slightly, so as to bring together the cambium layers of the two branches. If the branches are simply twisted together closely, a union will usually take place at points of contact in the course of their natural growth, but extra pains taken in binding the parts for a time, and perhaps even covering them with wax, will usually be worth while. After a strong union has developed between two branches that have been treated in this way the ends and any side branches that occur can be cut away.

FIG. 23.—The formation of "natural braces" to prevent the splitting of limbs: *A*, A new brace early in its formation; *B*, a brace well advanced in its growth; *C*, a well-matured brace.

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